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NEMERTEANS FROM
CALIFORNIA AND OREGON

by

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INTRODUCTION

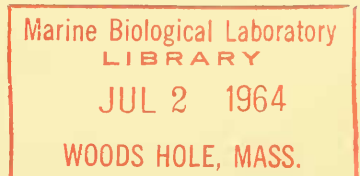
This paper is based principally on a collection of nemerteans made by me while on a John Simon Guggenheim Memorial Foundation Fellowship in the United States. I worked from March to August of 1958 at Pacific Marine Station, Dillon Beach, Marin County, California, where I was helped by Dr. Joel W. Hedgpeth, the director, Mr. Edmund H. Smith, and Dr. Ralph G. Johnson (University of Chicago). I stayed also for a short while at Scripps Institution of Oceanography, La Jolla, San Diego County, California, and took part in excursions in the San Diego area led by Dr. E. W. Fager of Scripps.

I am deeply indebted to Dr. J. W. Hedgpeth and to Dr. E. W. Fager for the kind hospitality conferred on me. Particular mention should be made of Mr. E. H. Smith and of Dr. R. G. Johnson for the great help they gave in collecting specimens.

During my stay at Allan Hancock Foundation, University of Southern California, Los Angeles, California, I had the chance to examine some of Coe's types of Pacific nemerteans deposited in the collection of that foundation. I am grateful to Dr. Olga Hartman for the use of the collection and her laboratory.

I wish to acknowledge to the Guggenheim Foundation, New York, and

[515]



to the Brazilian National Research Council, Rio de Janeiro, my gratefulness for the financial help awarded to me.

I also wish to thank Dr. Hedgpeth for reading the manuscript and submitting it for publication.

The main papers relating to the nemerteans of the Pacific Coast of North America are those of Griffin (1898) and Coe (1901, 1904, 1905, 1940, 1944, and 1952).

The material, preserved as well as sectioned worms, is deposited in the Department of Zoology of the Faculty of Philosophy, Sciences and Letters of the University of São Paulo, P. O. B. 8105.

The systematic arrangement followed here is that of Hyman (1951). The present paper deals with the following 22 species:

Phylum RHYNCHOCOELA (Nemertini)

Order PALAEONEMERTINI

Family TUBULANIDAE

Genus *Tubulanus* Renier, 1804

1. *T. polymorphus* Renier, 1804
2. *T. sexlineatus* (Griffin, 1898)
3. *T. cingulatus* (Coe, 1904)

Family CARINOMIDAE

Genus *Carinoma* Oudemans, 1885

4. *C. mutabilis* Griffin, 1898

Family CEPHALOTHRICIDAE

Genus *Procephalothrix* Wijnhoff, 1910

5. *P. spiralis* (Coe, 1930)

Order HETERONEMERTINI

Family LINEIDAE

Genus *Lincus* Sowerby, 1806

6. *L. ruber* (Müller, 1771)
7. *L. pictifrons* Coe, 1904

Genus *Cerbratulus* Renier, 1804

8. *C. montgomeryi* Coe, 1901
9. *C. occidentalis* Coe, 1901
10. *C. longiceps* Coe, 1901
11. *C. albifrons* Coe, 1901

Genus *Micrura* Ehrenberg, 1831

12. *M. verrilli* Coe, 1901
13. *M. wilsoni* (Coe, 1904)

Phylum Rhynchozoa (Nemertini)—Cont.

Order HOPLONEMERTINI

Family EMPLECTONEMATIDAE

Genus *Emplectonema* Stimpson, 185714. *E. gracile* (Johnston, 1837)Genus *Paranemertes* Coe, 190115. *P. peregrina* Coe, 1901

Family AMPHIPORIDAE

Genus *Zygonemertes* Montgomery, 189716. *Z. virescens* (Verrill, 1879)Genus *Amphiporus* Ehrenberg, 183117. *A. eruentatus* Verrill, 187918. *A. imparispinosus* Griffin, 189819. *A. formidabilis* Griffin, 1898

Family TETRASTEMMATIDAE

Genus *Tetrastemma* Ehrenberg, 183120. *T. nigrifrons* Coe, 1904Genus *Prostoma* Dugès, 182821. ? *P. rubrum* (Leidy, 1850)

Order BDELLOMORPHA (= Bdellonemertini)

Family MALACOBDELLIDAE

Genus *Malacobdella* Blainville, 182722. *M. grossa* (Müller, 1776)

LIST OF LOCALITIES

1. Neighborhood of Dillon Beach (Second Sled Road), Marin County, California; intertidal zone. "Dillon Beach is a partly protected sandy beach on the southern shore of Bodega Bay, Marin County, at about 38° 15' N. and 122° 58' W. It is the site of a resort community situated on the bluffs overlooking the shore, and, in recent years, of the Pacific Marine Station, a branch of University of the Pacific. Many collection records in the literature of marine invertebrates refer to the rocky areas immediately north of the beach proper. To the south of Dillon Beach itself, beyond Sand Point, the promontory which marks the southern limit of Bodega Bay, are extensive areas of muddy sand and eel grass, known as High Clam Flat and Eel Grass Flats respectively. This area, lying within the limits of Tomales Bay, comprises one of the finest examples of the development of ecological communities of the Pacific Coast, with extensive aggregations of clams, worms, burrowing shrimps, and phoronids. Westward, across Bodega Bay, lies the bold

granite headland of Tomales Bluff, with its tidepools and sheltered crevices.

"In the 1890's when Dillon Beach could be reached from the nearby hamlet of Tomales via the narrow gauge railroad whose roadbed still leaves its traces on the landscape (Shaw *et al.*, 1949), zoologists paid frequent visits to the area, and Dillon Beach soon entered the literature as a type locality (Hedgpeth, 1951, p. 105)."

The worms live inside holdfasts of the large and abundant phaeophycean alga *Egregia menziesii* (see Ricketts and Calvin, 1956, p. 388, fig. a), in crevices of rocks, on alga straps, among mussel beds and other growths. The old holdfasts are the best for collecting the worms not only because they have numerous holes and interstices which are suitable places for the animals to hide, but also because they are more easily detached from the rocks. The best way to collect the worms is to bring old holdfasts to the laboratory and carefully open them in order to obtain complete animals. On shady days they crawl out of the holdfasts which makes it easier to collect them. The nine species collected from the neighborhood of Dillon Beach are *T. polymorphus* Renier, 1804; *T. scolineatus* (Griffin, 1898); *C. occidentalis* Coe, 1901; *E. gracile* (Johnston, 1837); *P. peregrina* Coe, 1901; *A. cruentatus* Verrill, 1879; *A. imparispinosus* Griffin, 1898; *A. formidabilis* Griffin, 1898; *T. nigrifrons* Coe, 1904.

2. Shell Beach, Sonoma County, California, about 13 miles (24 kms.) north of Pacific Marine Station, just below the mouth of the Russian River. Intertidal zone. The same biotope as locality 1, except for *M. verrilli* which was found under roots of eelgrass, *Zostera marina* Linnaeus, attached to sandy bottom. The seven species obtained at Shell Beach are *T. polymorphus* Renier, 1804; *T. scolineatus* (Griffin, 1898); *L. ruber* (Müller, 1771); *L. pictifrons* Coe, 1904; *M. verrilli* Coe, 1901; *M. wilsoni* (Coe, 1904); *E. gracile* (Johnston, 1837).
3. Clear Lake, Lake County, California. Under pebbles in shallow water. Collected in the early evening at sunset time. A single species, ? *P. rubrum* (Leidy, 1850), was taken here.
4. Southwest side of Sunset Bay, Charleston, Coos County, Oregon. Intertidal zone. Commensal in the mantle cavity of the lamellibranch *Siliqua patula* (Dixon) the "razor clam." Up to 80 per cent of these clams, according to canners, carry the worms. The percentage of clams so accompanied increases toward the north (Ricketts and Calvin, 1956, p. 195). *Malacobdella grossa* (Müller, 1776). *Cercbratulus albifrons* Coe, 1901, was found under stone at this locality, too.

5. Tomales Bay, Marin County, California. Intertidal zone. On mud and eelgrass flats a few steps south to Pacific Marine Station. Only *P. peregrina* Coe, 1901, was collected here.
6. Inner coast of Tomales Point, Marin County, California. Intertidal zone. In coarse sand at low tide. *Procephalothrix spiralis* (Coe, 1930) was found here.
7. White Gulch, Tomales Bay, Marin County, California. Dredged at about 18 feet (6 m.), from a substratum of medium sand associated with *Solen rosaceus* Carpenter, the "jackknife clam" and a sabellid polychaete. Collected by Dr. R. G. Johnson. The following four species were collected here: *T. cingulatus* (Coe, 1904) (coll. no. 1-58-1); *C. occidentalis* Coe, 1901 (coll. nos. 1-58-3, 4, 6, 11); *C. longiceps* Coe, 1901 (coll. nos. 1-58-17, 26); *C. albifrons*, Coe, 1901.
8. Outer coast of Tomales Point, Marin County, California. Intertidal zone. The same biotope as locality 1 except for *M. verrilli* which was found under roots of eelgrass. Five species as follows: *T. polymorphus* Renier, 1804; *T. serlineatus* (Griffin, 1898); *C. montgomeryi* Coe, 1901; *M. verrilli*, Coe, 1901; *A. formidabilis*, Griffin, 1898.
9. La Jolla, San Diego County, California. Intertidal zone. Two species were collected here: *T. serlineatus* (Griffin, 1898), probably from growths on rocks in the vicinities of Scripps Institution of Oceanography, and *C. mutabilis* Griffin, 1898, burrowing in sand close to the pier of the same institution. Collected by Dr. E. W. Fager.
10. Point Loma reef near Lighthouse, San Diego County, California. Intertidal zone. Only among algae. *Z. virscens* (Verrill, 1879), was taken here.

GENERA AND SPECIES

Tubulanus Renier, 1804.

REFERENCES: FRIEDRICH, 1936, p. 30. COE, 1943, p. 226.

Body soft, cylindrical, delicate, capable of great contractibility; head often flattened dorsoventrally, triangle-shaped or disk-like, wider than the trunk and separated from it by a constriction; cephalic furrows distinct; eyes lacking; numerous epidermic glands; internal circular muscles well developed at level of anterior gut, often with two muscle crosses with external circular muscles; mouth immediately behind brain; median gut without diverticula; proboscis pore subterminal; proboscis short; proboscis sheath not longer than half of body length; nervous system completely situated between basement membrane and external circular musculature;

cerebral sense organs as epithelial pits or canals with structure simple; lateral sense organs present in esophageal region.

Tubulanus polymorphus Renier, 1804.

PRINCIPAL REFERENCES: BÜRGER, 1892, p. 140, as *Carinella polymorpha*; 1895, pp. 517-519, pl. 1, figs. 4, 10; pl. 12, figs. 3-4, 6, 9-13, 18; pl. 22, figs. 5-9, 21-22, 24-26; pl. 23, figs. 29, 31, 33; pl. 24, figs. 6, 9; pl. 26, fig. 3, pl. 27, figs. 5, 24, 48, 49, as *C. polymorpha*; 1904, p. 12. COE, 1901, 1904, pp. 11-14, pl. 3, fig. 6; pl. 9, figs. 1-3; pl. 10, figs. 1-2, as *C. speciosa*; 1904, p. 115, as *C. rubra*; 1905, pp. 109-111, pl. 1, fig. 1; text figs. 2, 14, 24, as *C. rubra*; 1940, p. 256; 1944, p. 27. FRIEDRICH, 1958, p. 4. GONTCHAROFF, 1955, p. 4. GRIFFIN, 1898, p. 203, as *C. rubra*. HYLBOM, 1957, pp. 548-549. JOUBIN, 1890, pp. 486-487, as *C. polymorpha*. PUNNETT, 1903, p. 11, as *C. polymorpha*. RICKETTS and CALVIN, 1956, pp. 147, 230, as *C. rubra*. SOUTHERN, 1913, p. 3. WIJNHOF, 1912, p. 409.

MATERIAL. Several worms from March to July, 1958. Localities 1, 2, 8. Rather common.

DISTRIBUTION: Northern coasts of Europe; Mediterranean; Aleutian Islands, Alaska, British Columbia to Monterey Bay, California. Intertidal zone.

The living mature worms are up to 50-75 cm. long. Coe (1901, 1904, p. 12) gives a length up to 3 m. The maximum width is about 4-5 mm., behind the constriction between the head and the trunk. The anterior end is rounded. The proboscis pore is situated in its anteroventral, subterminal tip. The posterior end is slender. The color of the whole body is a deep, brilliant, uniform red. The worms, preserved in hot "Susa," have lost their bright appearance and acquired a uniform dull grayish color. A brown band appears around the body in preserved worms. In a specimen 50 cm. long the band begins about 15 mm. behind the tip of the head. It is about 5 mm. wide and distinct, fading away backward. A longitudinal line is present as a shallow groove on each side of the body, from the constriction to the posterior end. The large mouth, a longitudinal slit, bordered by a few villousities, lies behind the constriction on the ventral side. The lateral sense organs are situated shortly behind the brown band (Bürger, 1895, pl. 1, fig. 10).

The epidermis is thick and rich in glands throughout the body. The basement membrane, thin in the anterior part of the body, becomes thick posteriorly to the brain and there it shows fibers rather distinct which are crossed by fibers from the external circular muscles to the epidermis. Both circular layers, the external and the internal are thinner than the median longitudinal one. The muscular crosses between the two circular layers are

Distributions or further occurrences for all the species treated here are from Coe, 1940, 1944, 1951, 1951a, 1952 and Corrêa, 1961.

very feeble. They are represented only by some thin fibers which pass from one layer to the other just beneath the dorsomedian longitudinal nerve. Some muscular crossing fibers occur also ventrally. The central plate of longitudinal muscles, situated between the digestive tract and the rhynchocoel, is thin. It extends from the mouth level backward. The cephalic glands are very highly developed. In front of the rhynchodaeum region they are more abundant dorsal to the blood lacuna. At the level of the proboscis pore and backward they are abundant, also all around the rhynchodaeum and blood lacuna. They fill most of the space of the tip of the head but do not reach far backward. The most posterior glands are situated far in front of the brain. Their secretion stains intensely with hematoxylin.

The proboscis pore is small. The rhynchodaeum is lined by a glandular and ciliated epithelium. Its glands are like the cephalic glands both in aspect and staining characteristics. The lumen of the rhynchodaeum is very narrow proximally and opens behind into an anterior rhynchocoelic pouch whose wall is without gland cells and cilia. The pouch is followed by the large rhynchocoel proper. The rhynchocoel wall is composed of an epithelium lining the cavity and a layer of circular muscles. Dorsally this layer contacts the external circular musculature and ventrally it contacts the longitudinal muscular plate. The proboscis wall is composed of a high external epithelium, a thin layer of circular muscles, a thicker layer of longitudinal muscles, and an internal epithelium. There are two longitudinal proboscis nerves.

There is one large anterior blood lacuna subdivided by dorsoventral fibers and two large postcerebral ones, one on each side of the gut.

The nervous system is situated between the basement membrane and the external circular muscles. There is a ring of large anterior nerves originated from the ganglia and commissures. Backward run the dorsomedian nerve, the rhynchocoelic nerve, the proboscis nerves, and the short esophageal nerves. The cerebral sense organs are highly developed. They lie immediately external to the dorsal ganglia and are innervated by the adjacent ganglion. They consist of a rounded mass of nerve cells surrounding a narrow, central canal, lined with a ciliated and sensory epithelium. The central canal leads ventrally and outward to open through the epidermis by a small pore.

Tubulanus sexlineatus (Griffin, 1898).

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 15-16, pl. 1, figs. 2-3, as *Carinella dinema*; 1904, p. 115, as *C. sexlineata*; 1905, pp. 111-114, pl. 1, figs. 2-3, pl. 15, figs. 90-92, as *C. sexlineata*; 1940, p. 256; 1944, p. 27. GRIFFIN, 1898, pp. 201-203, text fig. 15, as *C. exlineata*.

MATERIAL. Several worms from April to July, 1958. Localities 1, 2, 8, 9. Rather common.

DISTRIBUTION. Alaska to southern California. Intertidal zone.

The living worms are up to 10 cm. in length and about 0.8 mm. in maximum width. Coe (1905, p. 114) gives 20 cm. as average size, varying from 7.5 cm. to 1 m. The ground color is dark reddish-brown with five very characteristic longitudinal white lines, three of which are on the back and two on the ventral side. All five longitudinal lines run nearly the whole length of the body. Of the three back lines one is median and the other two are lateral. A sixth medioventral line is shown as white spots on the anterior part of some of the worms. Besides the longitudinal lines there are also a great number of white rings, variable in width and situated at different distances from each other. The white rings are single or double lines. When double they have a brown ring between the pair. The anterior end has dorsally an irregular, transverse, white line and on both sides a black narrow groove which extends from the proboscis pore to the white line. The first trunk rings are somewhat irregular, sometimes present only dorsally. The fifth ring is broader than any of the remaining rings. Close to it there is on each side a shallow pit, the lateral sense organ. Several white spots occur on the dorsal and ventral sides in front of the first white ring and between the following four rings. The posterior end is yellowish-white both dorsally and ventrally. The large mouth is situated behind the constriction between head and trunk. The worms live in thin, transparent tubes, secreted by their epidermis.

The glandular epidermis is thick. The basement membrane is thin anteriorly and thick posteriorly to the brain. Before the brain there is an external layer of circular muscles, a thicker layer of longitudinal muscles, and a coat of circular muscles around the rhynchodaeum and blood vessels. Behind the mouth all three layers of muscles, the external circular, the median longitudinal, and the internal circular, are typical and complete. The muscular crosses between the two circular layers are almost completely wanting. A layer of central longitudinal muscles, the central plate, lies between rhynchocoel and anterior gut. Cephalic glands are absent in the present species as in other species of the genus *Tubulanus* (Bürger, 1897-1907, p. 409) and in most of the Palaeonemertini (Bürger, 1895, p. 229). Friedrich (1936a, p. 103) has found some differences between the dorsal and ventral glands of the rhynchodaeum epithelium of *T. borealis* Friedrich, 1936. The same differences were also noted in *T. rhabdotus* Corrêa, 1954, where vacuolated cells occur besides stained glands (Corrêa, 1954, p. 15, pl. 2, fig. 8). The absence of true cephalic glands and the similarity between them and the vacuolated rhynchodaeal cells indicate a homology of both types. However I could not distinguish any difference in the rhynchodaeum glands in the present species, as I would expect owing to the absence of true cephalic glands.

The proboscis pore is situated subterminally, ventrally, at the anterior tip. The large rhynehodaemum is lined by a highly glandular epithelium. Anterior to the constriction between head and trunk the glands disappear and the rhynehodaemum passes to the rhynehocoel. A quite strong and complete muscular proboscical septum is present in this region. Some of its fibers are retained in the anterior wall of the rhynehocoel. The rhynehocoel wall is composed of an epithelium, a distinct basement membrane, and a thick layer of circular muscles where a longitudinal nerve runs dorsally. Dorsally the circular muscles are thick layered because they contact the internal circular muscles of the body wall and ventrally they are thinner and touch the central plate of longitudinal muscles. Anteriorly to the nephridiopores, at the level of the stomach, there are longitudinal thickenings of the internal wall of the rhynehocoel, on both sides, close to the lateral blood vessels. They are the rhynehocoelic bodies described by Friedrich (1936a, p. 107) in *T. borealis* and by Corrêa (1954, p. 16) in *T. rhabdotus*. They are united to the lateral blood vessels by sometimes large canals. The rhynehocoelic bodies are covered by the rhynehocoelic epithelium and are composed of a mass of cells. As in *T. serlineatus* there are no rhynehocoelic vessels, I follow the opinion of Friedrich (1936a, p. 108) about the nephridial function of the rhynehocoelic bodies. The proboscis wall is composed of an external epithelium, the external basement membrane, a thin layer of circular muscles, a thicker layer of longitudinal muscles, the internal basement membrane, and the flat internal epithelium. The two proboscical, longitudinal nerves, are situated between the external basement membrane and the circular muscular layer. They arise independently from the ventral cerebral commissure and enter the proboscis at its attachment point.

The pre- and postcerebral vessels are true vessels, because they have defined walls with a muscular coat and epithelium (Hyman 1951, p. 488). In the precerebral part they are subdivided incompletely by dorsoventral muscular strands. Behind the mouth there is only one vessel on each side situated within the longitudinal musculature.

The nephridial system is situated in the first third of the body. It begins, on both sides of the body, with the well developed nephridial glands, a mass of minute tubules lined with a flattened epithelium. The glands project into the lumen of the lateral blood vessel along its lateral border. The nephridial glands pass through the vessel wall and continue as a longitudinal duet situated dorsolaterally to the blood vessel. The wall of the duets is lined by a ciliated epithelium. Close to the level of the lateral sense organs the duets pass outward through the epidermis and open by one dorsolateral nephridiopore on each side.

The nervous system is composed of two pairs of ganglia united dorsally and ventrally by commissures forming a nerve ring. It is situated between

the basement membrane and the external circular musculature. The nerve ring gives origin to a large number of anterior nerves. The dorsomedian nerve belongs to them. From their thick origin they become slender forward and send branches into the epidermis. Backward run the dorsomedian nerve, the rhynchoeolic nerve, the two lateral nerve cords, the two proboscidal nerves, and the esophageal nerves. The cerebral sense organs are simple. They consist of a ciliated canal innervated by some fibers from the dorsal ganglia. The lateral sense organs are a pair of rounded pits situated dorsal to the lateral nerve cords in the epidermis outside the basement membrane. They are innervated by fibers from the lateral nerve cords.

Tubulanus cingulatus (Coe, 1904).

PRINCIPAL REFERENCES: COE, 1904, pp. 138–142, pl. 14, figs. 2–4, as *Carinella cingulata*; 1905, pp. 120–122, as *C. cingulata*; 1940, p. 255; 1944, p. 27.

MATERIAL. Several worms in June and July, 1958. Locality 7. Rather common.

FURTHER OCCURENCES. Alaska; Monterey Bay, California. Intertidal zone to 400 m. The present record links the distribution between Alaska and Monterey Bay, California.

The living worms are up to 15 cm. in length and about 2–3 mm. in maximum width. The ground color is deep brown with longitudinal white lines and thin white rings bordered with brown. The longitudinal lines are four in number, two are dorsolateral and the two other ventral, very near to the lateral margins of the body. Behind the constriction between the head and trunk there is a deep brown ring thinner on the ventral side and interrupted there by the large mouth. It is followed by a distinct white band which is the anterior limit of the white longitudinal lines. On both sides of the paler head there is a narrow, transverse, terminal, brown line. The space between the anterior rings is broader than the spaces between the more posterior rings. The proboscis pore is situated ventrally, subterminally on the head which is broader than the trunk. The lateral sense organs are well visible on the anterolateral border of the third white ring.

As the internal anatomy of *T. cingulatus* is quite similar to that of the preceding species, I give only a few divergent points.

The dorsoventral, precerebral musculature is much stronger. The muscular crosses between the external and internal circular muscles are quite strong, principally the dorsal one. True cephalic glands, which lie in the cephalic musculature or sometimes behind the brain, are absent. A difference is noted between the dorsal and ventral glands of the rhynchodaeum epithelium. Dorsally they are vacuolated cells and ventrally they are deep stained basophilous glands. At the limit between rhynchodaeum and rhynchoeol the former continues backward as a postventral blind sac.

OTHER SPECIES OF THE GENUS. The genus *Tubulanus* contains 29 species (Corrêa, 1954, pp. 21-25; Iwata, 1952, pp. 126-128; Friedrich, 1958, p. 3). Three of them are presented here and five more occur on the northeastern Pacific coast. They can be separated from *T. polymorphus*, *T. scx'ineatus*, and *T. cingulatus* by the following external characteristics:

1. ***Tubulanus pellucidus*** (Coe, 1895). Recently redescribed by Corrêa (1961, pp. 4-5, figs. 1-4). Body filiform, small, about 20 mm. long and 0.3 mm. broad; whitish in color. Occurrences: Coasts of New England and southward to Miami, Florida and Pensacola, Florida on the Gulf Coast; Monterey Bay, California to San Diego, California. Intertidal zone.
2. ***Tubulanus capistratus*** (Coe, 1901). Long, slender, up to 1 m. long; color deep brown with three longitudinal white lines one of which is dorsal and one on each ventrolateral margin; a series of narrow white rings along the whole length of the body. Occurrences: Coast of Alaska to Monterey Bay, California; Japan. Intertidal zone.
3. ***Tubulanus albocinctus*** (Coe, 1904). Rather stout body about 30 cm. long; color deep red with a series of narrow white rings along the whole length of the body; longitudinal lines absent. Occurrence: Off the coast of southern California. Among red algae at depths of 100 to 200 m.
4. ***Tubulanus frenatus*** (Coe, 1904). Body long, 50 cm. or more; color pale yellowish or rosy with three longitudinal black lines one of which is dorsomedian and the other two are situated on or a little beneath the lateral margins; a series of narrow, black rings extends along the whole length of the body. Occurrence: Southern California. Intertidal zone.
5. ***Tubulanus nothus*** (Bürger, 1892). Small, 10 cm. long; color brownish-red with two longitudinal lateral lines, one dorsomedian and a series of white rings. Coe (1944, p. 27) is not sure about the identification of this species which was seen by him only in preserved specimens from Alaska. Occurrences: Coast of Alaska; South Africa; Mediterranean. Intertidal zone to 40 m.

Genus **Carinoma** Oudemans, 1885.

REFERENCE: FRIEDRICH, 1936, p. 31.

Anterior part of body in region of anterior gut with layer of external longitudinal museles; brain and anterior course of lateral nerve cords between external circular and external longitudinal muscular layers, posteriorly these cords farther inward.

Carinoma mutabilis Griffin, 1898.

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 20–23, text figs. 1–2, as *C. griffini*; 1904, p. 115; 1905, pp. 144–153, pl. 12, figs. 76–80; pl. 13, figs. 81–82; pl. 14, figs. 83–87; pl. 15, figs. 88–89; 1940, p. 257, pl. 25, figs. 21–22; 1944, pp. 27–28. FRIEDRICH, 1956, pp. 3–5. GRIFFIN, 1898, pp. 204–205, text fig. 16.

MATERIAL. One worm. Locality 9.

DISTRIBUTION. British Columbia to Gulf of California. Intertidal zone to 40 m. Burrows on sandy shores of bays.

The preserved cylindrical worm was about 30 cm. long and 2–3 mm. broad. The rounded head is wider than the trunk. The color is uniformly grayish.

Unfortunately my single specimen of this little-known genus was not properly preserved and had been kept for a long time before it reached me. Consequently I can not give any details of the external or internal anatomy. The specific name was given only according to the occurrence. It is the only species of the genus on the Pacific coast of North America (Coe, 1940, p. 257).

Friedrich (1956, pp. 3–5) examined two specimens of the genus *Carinoma* collected on the coast of Chile by the Lund University Expedition 1948–49. He did not attempt to determine this material because the five hitherto-known species of *Carinoma* are not sufficiently described.

Genus **Procephalothrix** Wijnhoff, 1910.

REFERENCE: FRIEDRICH, 1936, p. 30.

Mouth far behind brain; internal circular musculature of body present in region of anterior gut; muscle crosses absent; brain and lateral nerve cords situated within longitudinal muscular layer; esophageal nerve unpaired; sense organs absent, in their place a nervous glandular tissue.

Procephalothrix spiralis (Coe, 1930).

PRINCIPAL REFERENCES: COE, 1905, pp. 153–154, as *Cephalothrix linearis*; 1930, pp. 101–103, text figs. 4–8, as *C. spiralis*; 1940, pp. 258–259, pl. 28, fig. 37; 1943, pp. 230–232, text figs. 19, 44; 1944, p. 28. VERRILL, 1892, pp. 442–443, pl. 36, figs. 4–5; pl. 39, figs. 10–15, as *C. linearis*.

MATERIAL. Several worms in July 1958. Locality 6. Very common.

DISTRIBUTION. New England; Alaska to San Diego, California. Intertidal zone to 20 m.

Alive, the filiform mature worms are up to 20 cm. long and 1–2 mm. wide. The color is variable from whitish to gray, pale yellow and light rosy often with pinkish, greenish, or salmon tinge posteriorly. They can be

easily distinguished by the far-posterior position of the mouth and by the habit of fragmenting and coiling the body into a spiral. All the worms, collected in large numbers, were completely fragmented at their arrival in the laboratory. The head is very long and acutely pointed. Eyes are absent in the adults. A single pair of ocelli is present in larval stages and young adults (Coe, 1943, p. 231, textfig. 44).

Besides *P. spiralis*, a second species of *Procephalothrix*, *P. major* (Coe, 1930), is known on the Pacific Coast of North America. It can be separated from *P. spiralis* by its larger size, up to 1 m. in length and 5 mm. in width; by its ochre, or straw color; its more rosy color in front, and its grayish color behind; and by its slight tendency to coil into a spiral. Occurrence: southern California. Beneath stones in hard sand or clay fully exposed to surf. Intertidal zone.

Genus **Lineus** Sowerby, 1806.

REFERENCE: FRIEDRICH, 1936, p. 31.

Cephalic slits present; cutis not separated from musculature by connective tissue; layer of circular muscles dissolved in tip of head into radial and tangential fibers; dorsoventral muscles between intestinal pouches wanting; proboscis with two muscular layers: external circular and internal longitudinal; proboscis with two muscle crosses; cephalic blood lacuna uniform; blood vessels united at posterior end by a simple commissure.

Lineus ruber (Müller, 1771).

PRINCIPAL REFERENCES: BOIE, 1952, pp. 188-222, text figs. 1-17. COE, 1901, 1904, pp. 65-66, text fig. 16, as *L. viridis*; 1905, pp. 162-163, as *L. viridis*; 1940, p. 268, 1943, pp. 242-244, text figs. 33, 36, 48; 1944, p. 29. FRIEDRICH, 1935, pp. 307-310, text figs. 8-9. GONTCHAROFF, 1951, pp. 149-235, pls. 1-7. MCINTOSH, 1873-74, pp. 188-190, pl. 5, fig. 2, as *L. sanguineus*. SOUTHERN, 1913, p. 9. STEPHENSON, 1913, pp. 25-27. VERRILL, 1892, pp. 418-423, pl. 37, figs. 5-5b; pl. 38, figs. 6-6d; pl. 39, figs. 18, 22, as *L. viridis*; pp. 423-424, pl. 38, figs. 10-10a, as *L. sanguineus*. WHEELER, 1934, pp. 229-230, pl. 15, fig. 4, text fig. 6; 1940, pp. 31-32, figs. 5A-G. WLNHOFF, 1912, p. 416.

MATERIAL. Two worms in June, 1958. Locality 2. Uncommon.

DISTRIBUTION. Circumpolar; Siberia; Northern coasts of Europe; Mediterranean; Madeira to South Africa; Greenland to Southern New England; Alaska to Monterey Bay, California. Intertidal zone to 10 m. Gontcharoff (1951, p. 155) is doubtful about the occurrence of the species in the Mediterranean. She has not collected it in Marseille and Banyuls, France.

The worms measured in life about 8 cm. in length and 1 mm. in maximum width. The color is brownish-red on the back and paler beneath. On the tip of the head there is one unpigmented zone. There are a few eyes, about 4-5 on each side, situated on the anterolateral margins.

The internal and external anatomy of the species was recently analyzed thoroughly by Friedrich (1935) and Gontcharoff (1951).

As far as I could see in my specimens, they belong to the *L. ruber* complex (Gontcharoff, l.e.) composed of *L. ruber*, *L. viridis* (Blainville, 1828), *L. sanguineus* (Rathke, 1799), and *L. pseudo-lacteus* Gontcharoff, 1951.

***Lineus pictifrons* Coe, 1904.**

PRINCIPAL REFERENCES: COE, 1904, pp. 188–192, pl. 17, figs. 5–6; 1905, p. 169–171, pl. 3, fig. 36; 1940, p. 268; 1944, p. 28.

MATERIAL. One worm in July, 1958. Locality 2. Uncommon.

DISTRIBUTION. Puget Sound to coast of Mexico. Intertidal zone.

The worm was in life about 12 cm. long and 3 mm. wide. Body soft and flattened; head narrower than body; ocelli wanting. General color, deep brown or reddish both dorsally and ventrally. Posterior end paler. A series of numerous, transverse, yellow rings are present, as well as longitudinal yellow lines. The most anterior transverse markings encircle the body. The first one, situated at the posterior end of the longitudinal cephalic slits, is the widest. It is present only dorsally, as are the posterior ones. Almost all markings have a thickening on the median-dorsal line. The longitudinal lines are very thin, irregular and interrupted, except the median one which is rather conspicuous and connects all the thickenings of the transverse markings. The tip of the snout has a peculiar and characteristic yellowish band enclosing two orange colored spots.

OTHER SPECIES OF THE GENUS. Eight species of the genus *Lineus* are known on the Northeastern Pacific coast. Besides the two described here five more occur on the California coast. They can be separated by the following external characteristics:

1. ***Lineus bilineatus*** (Renier, 1804). Dark brown or olive with median-dorsal stripe of white or yellow extending the whole length of body and widening out on head to form a broad white marking; without transverse markings. Occurrences: Northern coasts of Europe; Mediterranean; Madeira; South Africa; Alaska to San Diego, California. Near low-water mark and below.
2. ***Lineus torquatus*** Coe, 1901. Dark reddish-brown or purple with a single narrow whitish band connecting posterior ends of cephalic furrows on dorsal side of head. Occurrences: Coast of Alaska to San Francisco Bay, California. Intertidal zone.
3. ***Lineus rubescens*** Coe, 1904. Small species, 10–15 mm. long; pink, rosy, or pinkish-red, sometimes with a tinge of blue; tip of head white both

above and below, sharply marked off from rosy color of body. Occurrences: Monterey Bay, California to San Diego, California. Near low-water mark and below.

4. **Lineus flavescens** Coe, 1904. Small species, 8–120 mm. long; yellowish, pale yellow with a tinge of orange, dull orange, ocher or yellowish-brown; margins of head pale or colorless; with 3 to 7 irregular red, purple, or black ocelli of which the most anterior are largest. Occurrences: southern California to Gulf of California, Mexico. Near low-water mark to 100 m. or more.
5. **Lineus vegetus** Coe, 1931. About 15 cm. long and uniformly reddish-brown except for the anterior tip which is pure white. Coe (1940, p. 266) separates *L. vegetus* from *L. ruber* on the basis of behavior and regenerative capacity. Occurrences: San Francisco Bay, California to Ensenada, Mexico. Intertidal zone.

Genus **Cerebratulus** Renier, 1804.

REFERENCE: FRIEDRICH, 1960, p. 57.

In general large animals with sharp lateral edges; with a small tail; diagonal muscular layer present; strong dorsoventral muscles; cutis set off against external longitudinal muscles; median gut with very deep lateral pouches; proboscis with external longitudinal muscles, circular muscles and internal longitudinal muscles, and two muscle crosses.

Cerebratulus montgomeryi Coe, 1901.

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 80–82, pl. 6, figs. 1–2; 1905, pp. 200–201, pl. 3, figs. 38–39; 1940, p. 276; 1944, p. 29. RICKETTS and CALVIN, 1956, p. 230.

MATERIAL. One worm in May, 1958. Locality 8. Uncommon.

DISTRIBUTION. Coast of Siberia; Bering Sea; Alaska to Monterey Bay, California; Japan. Intertidal zone to 600 m.

The worm was in life about 80 cm. long and 5 mm. wide. Coe (1905, p. 200) gives a length of up to three meters when fully extended. The color is both above and below bright pinkish red, fading toward the posterior tip. The tip of the head is white both dorsally and ventrally. The pointed head is variable in shape according to the state of contraction, flattened dorsoventrally, and well separated from the trunk by a constriction. It bears on each side a longitudinal slit extending backward as far as the anterior end of the mouth. Anteriorly these slits do not reach the proboscis pore. Ocelli wanting. The anterior portion of the body is cylindrical and the intestinal region is flattened. The posterior tip is sharply pointed. The

caudal cirrus was lost. The body coils into a spiral both in life and in the preserved state.

The epidermis is highly glandular but flat. The epidermis of the cephalic slits is poor in glands and bears longer cilia than in the rest of the body. The basement membrane is thin. In front of the brain there is a dense net of muscular fibers around the rynchodaeum and haemal system, in which occur the voluminous cephalic glands. The longitudinal external muscles are diffusely distributed and the circular and internal longitudinal layer encircle the rynchodaeum and blood vessels. At the posterior level of the brain the layers of body musculature are complete. Beneath the epidermis there is a thick layer of glandular cutis followed by the thick external longitudinal muscles, the circular muscles, and the internal longitudinal muscles. Cutis and external longitudinal musculature are not separated by connective tissue. The layers of the body wall are interrupted ventrally at the esophagus level.

The postcerebral small mouth opens into a villous, ciliated and glandular esophagus. The gut is provided with lateral diverticula.

The proboscis pore is a longitudinal, subterminal, ventral slit. The rynchodaeum is lined by a ciliated epithelium. The rynchocoel wall is composed of an epithelium, a layer of longitudinal muscles, and a thicker layer of circular muscles which are connected dorsally with the circular muscles of the body wall. The proboscis wall is composed of a high external epithelium, an external layer of circular muscles, a thicker layer of longitudinal muscles, an extremely thin layer of internal circular muscles, and the flat internal epithelium. Coe (1901, 1904, p. 81) describes an inner circular layer and later (1905, p. 200) recognizes it as absent. In fact the layer is present but very much interrupted. The muscular crosses between the two circular layers are very feeble.

***Cerebratulus occidentalis* Coe, 1901.**

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 76-77, pl. 6, fig. 3; 1905, pp. 197-198; 1940, p. 276; 1944, p. 29.

MATERIAL. Seven worms in June and July, 1958. Locality 1, 7.

DISTRIBUTION. Alaska to San Francisco Bay, California. Intertidal zone to 120 m.

The largest worm was 8 cm. long alive and 3 mm. wide. The usual color is brown or reddish-brown anteriorly and lighter in intestinal region; ventral surface brownish with a median ocher stripe. The small, pointed head bears on each side a rather short longitudinal slit. Ocelli wanting. The mouth is large. The body is slightly rounded anteriorly and flattened posteriorly. The posterior tip is pointed and bears a very short tail about 1 mm. long.

The internal anatomy of the four species of *Cerebratulus* described here is quite uniform. In the present species the internal circular layer of proboscoidal muscles is thicker than in *C. montgomeryi*, but the muscular crosses are also inconspicuous.

***Cerebratulus longiceps* Coe, 1901.**

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 77-79, pl. 5, figs. 4-7; 1905, pp. 199-200; 1940, p. 276; 1944, p. 29.

MATERIAL. Three worms in June and July, 1958. Locality 7. It is the first record of the species on the California coast.

FURTHER OCCURRENCES. Alaska; Japan. Intertidal zone to 250 m.

The largest worm measured in life 30 cm. in length and 6 mm. in maximum width. The dorsal surface is dark brownish-black or purplish, much paler on the tip of the snout and on the borders of the cephalic furrows. The ventral surface is paler. The body is much flattened throughout its length, the anterior portion narrow and slender becoming wider posteriorly. The head is long, pointed, flattened dorsoventrally, directly continuous with the trunk, and with the tip often curved upward. The cephalic furrows are very long, remarkably deep and wide. They do not reach the proboscis pore anteriorly, and posteriorly they reach the anterior border of the long slit-like mouth. A white, 3 mm. long tail, was present.

***Cerebratulus albifrons* Coe, 1901.**

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 82-83, pl. 4, figs. 3-4; 1904, pp. 200-201, pl. 17, fig. 9; 1905, pp. 198-199; 1940, p. 274; 1944, p. 29.

MATERIAL. Two worms in July, 1958. Localities 4, 7.

DISTRIBUTION. Alaska to San Diego, California. Intertidal zone to 100 m. or more.

The worms measured in life about 30 cm. in length and 5 mm. in maximum width. The color is uniform dark brown. The anterior end of the head is white, both dorsally and ventrally and extending backward as far as the anterior end of the mouth. The head is pointed and directly continuous with the trunk. It bears on each side a longitudinal slit. Ocelli wanting. The ribbon-like body is rounded anteriorly and flattened in intestinal region.

OTHER SPECIES OF THE GENUS. Nine species of *Cerebratulus* are known on the Pacific coast of North America. Besides the four species described here four more species occur on the California coast. They are:

1. ***Cerebratulus marginatus* Renier, 1804.** Length 50 cm. to 1 m.; brown to grayish or pale olive, paler beneath, with conspicuous paler or white

lateral margins. Occurrences: Circumpolar; Norway to Madeira; Greenland and Labrador to Cape Cod; Alaska to San Diego, California; Bering Sea; Japan. Sandy and muddy shores to depth of 100 m. Coe (1944, p. 29) does not list this species from the Mediterranean. It was collected by me in the Gulf of Naples (1952).

2. **Cerebratulus herculeus** Coe, 1901. Length 2 m. or more and width 25 mm.; dark reddish-brown. Occurrences: Bering Sea; coast of Alaska to central California and off the coast to depths of 60 m. or more.
3. **Cerebratulus californiensis** Coe, 1905. Small species, 10–15 cm. long; variable in color, pale yellow, light brown or chocolate brown; lateral margins thin and often paler; lateral nerve cords red. Occurrences: Puget Sound to Gulf of California. On muddy shores and in bays to depths of 35 m. or more.
4. **Cerebratulus lineolatus** Coe, 1905. Recently redescribed by Corrêa (1961, p. 14). Length 25 mm. to 20 cm.; pale gray, with numerous, fine, irregular and much interrupted dark olive-brown longitudinal lines extending the whole length of body both above and below, but more numerous and larger on dorsal surface than ventrally. Occurrences: Miami, Florida; southern California, Gulf of California, and West Coast of Mexico. Intertidal zone to 70 m. or more.

Genus **Micrura** Ehrenberg, 1831.

REFERENCE: FRIEDRICH, 1960, p. 59.

Cephalic furrows posteriorly widened as a pit from whose bottom parts cerebral canal; external longitudinal muscular layer of cutaneous-muscular tube stronger than circular and internal longitudinal muscular layers; dorsoventral and diagonal muscles lacking; post-cerebral or pre-esophageal dorsoventral and horizontal muscles lacking; pouches of median gut very shallow; coat of ganglionic cells of brain not separated by connective tissue from longitudinal external muscles.

Micrura verrilli Coe, 1901.

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 68–71, pl. 5, figs. 1–3; 1905, pp. 179–182, pl. 3, figs. 34–35; 1940, pp. 272–273; 1944, p. 29. GRIFFIN, 1898, pp. 214–215, as *Lineus striatus*. RICKETTS and CALVIN, 1956, p. 146, pl. 22, fig. 7.

MATERIAL. Ten worms from April to June, 1958. Localities 2, 8. Not uncommon. Unfortunately *M. verrilli* occurs not very frequently (Ricketts and Calvin, *l.c.*).

DISTRIBUTION. Alaska to Monterey Bay, California. Intertidal zone and below.

The largest worm was 15 cm. long alive and 3 mm. in maximum width. The body is compact and rounded throughout, only ventrally slightly flattened. Cephalic furrows rather large. Ocelli wanting. Caudal cirrus whitish and slender. General color of body is pure ivory-white dorsally and ventrally with a series of sharply defined rectangular markings of deep purple covering the greater portion of the dorsal surface, separated from each other by silver-colored lines. At the lateral borders of the purple markings is a continuous longitudinal line of the same silver color. On the dorsal surface of the head there is a triangular marking of bright orange color followed by a white band.

Micrura wilsoni (Coe, 1904).

PRINCIPAL REFERENCES: COE, 1904, pp. 195-198, pl. 16, figs. 10-11, as *Lineus wilsoni*; 1905, pp. 171-173, pl. 3, fig. 37, as *L. wilsoni*; 1940, p. 273; 1944, p. 29. JOUBIN, 1905, pp. 311-312, as *L. wilsoni*.

MATERIAL. One worm in April, 1958. Locality 2. Uncommon.

FURTHER OCCURRENCES. Monterey Bay, California, to Gulf of California. Intertidal zone to 35 m.

The worm was 4 cm. long. Coe (1905, p. 172) gives a length of 7 to 15 cm. Body moderately slender, rounded anteriorly, flattened in intestinal region, but with rounded lateral margins. Head very long and slender, not distinctly marked off from body. Cephalic furrows very long. Mouth large, situated far behind tip of snout immediately behind brain. Proboscis pore sub-terminal. Ocelli wanting. Color of body deep brownish-black dorsally, slightly paler ventrally. Head bordered anteriorly by a narrow terminal band of white which extends back along the borders of cephalic slits, so that when the slits are open they appear white. White terminal border narrower on ventral than on dorsal surface and less conspicuous owing to the paler color of the ventral surface. The tail is short and white. Body encircled at irregular intervals by a series of very fine white rings often lying in slight constrictions through which spontaneous fission takes place.

OTHER SPECIES OF THE GENUS. Eight species of the genus *Micrura* are known on the Pacific coast of North America (Coe, 1944, p. 29). Besides *M. verrilli* and *M. wilsoni*, described here, four more species may occur in the intertidal zone of the localities where I collected. These can be separated from *M. verrilli* and *M. wilsoni* by the following external characteristics:

1. ***Micrura alaskensis*** Coe, 1901. Body long and moderately slender, at-

taining a large size for the genus, commonly 15–60 cm.; color salmon, gray, pale red, or light rosy brown, shading into lighter hues; light red or yellow or nearly white anteriorly; a cream colored stripe often situated in median ventral line; without transverse rings. Occurrences: Alaska to Ensenada, Mexico; Japan. Intertidal zone.

2. **Micrura nigrirostris** Coe, 1904. About 40–80 mm. long; dorsal surface bright blood-red, ventral surface paler; head with a narrow, but very sharp and conspicuous, transverse band of white near tip of snout; on the tip of head there is a small, rounded, black spot with a few minute whitish flecks. Occurrence: southern California. Low-water mark and below.
3. **Micrura olivaris** Coe, 1905. Length 7 to 15 cm.; body small and stout; color pale olive brown, grayish ocher with deeper olive in intestinal region and paler median dorsal stripe in esophageal region; without transverse rings; small black ocelli in an irregular row of 6–12 on each side of head. Occurrences: Monterey Bay, California and off San Francisco, California. Low-water mark to 120 m.
4. **Micrura pardalis** Coe, 1905. About 3 cm. long; color pale yellow dorsally covered with black or dark brown spots often somewhat elongated and arranged in irregular longitudinal lines; without transverse rings; a single row, usually of 10 to 18 small ocelli, on each side of head. Occurrences: Monterey Bay, California to Ensenada, Mexico. Intertidal zone.

Genus **Emplectonema** Stimpson, 1857.

REFERENCES: FRIEDRICH, 1955, p. 172. CORRÊA, 1955, p. 68.

Long, filiform or flattened worms with short rhynchocoel; subepithelial glands often numerous, variously distributed or lacking; cephalic glands generally well developed but variable in length; muscular layers reach tip of head; dorsoventral museles present; esophagus opens into rhynchodaeum; caecum absent but two long anterolateral intestinal pouches present; an esophageal caecum exceptionally present; gut with lateral diverticula; proboscoidal septum of closed type; lateral nerve cords with one core of fibers; cerebral sense organs either small, far in front of brain, or large and shortly anterior to brain.

The genus *Emplectonema* was introduced by Stimpson (1857, p. 163) when he described *E. viride*, considered by him as new species. With the same name the species was described by Griffin (1898, pp. 207–209, figs. 17–18). *Borlasia camillea* Quatrefages, 1846, included by Stimpson (*l.c.*) in his *Emplectonema* is a synonym of *E. nesi* (Oersted, 1843) as was indicated by Bürger (1895, p. 544). As *E. viride* is identical with *Nemertes*

gracilis Johnston, 1837 (Coe, 1901, pp. 23-25) the type of the genus *Emplectonema* is *E. gracile* (Johnston, 1837), not *E. necsii* (Oersted, 1843), as Verrill indicated (1892, p. 413).

The cephalic glands are abundant and very long in my worms from Naples (Corrêa, 1955, p. 69, pl. 2, fig. 6g) and in the worms from California. My observations do not agree with Yamaoka's (1940, p. 238) of the same species from Japan where the cephalic glands are said to be absent. Bürger (1895, p. 542) included their presence in his diagnosis of the genus but did not give any drawing of cephalic glands in *E. gracile*.

I deduce from figure 27, plate 15 of Bürger (*l.c.*) that the long intestinal caecum mentioned on page 543 corresponds to the anterolateral intestinal pouches of my terminology. Stephenson (1913, p. 13) gave the same interpretation. With Böhmig (1929, pp. 16-17, figs. 19-20) followed by Friedrich (1956, pp. 45-53, pls. 1-2), I call the intestinal caecum a median, ventral, sub-stomachic projection. This caecum is absent in *E. gracile*.

Emplectonema gracile (Johnston, 1837).

PRINCIPAL REFERENCES: BÜRGER, 1895, pp. 543-544, pl. 2, fig. 1; pl. 9, fig. 24; pl. 15, figs. 21-27; pl. 22, fig. 27; pl. 24, fig. 53; pl. 26, figs. 39-41; pl. 27, figs. 1a, 12, 18, 20; pl. 29, fig. 3, as *Eunemertes gracilis*. COE, 1901, 1904, pp. 23-25, pl. 8, fig. 3; text fig. 3; 1905, pp. 207-208, pl. 1, figs. 14, 14a, 15, 15a; text fig. 32; 1940, pp. 279-280, pl. 30, fig. 40; 1944, pp. 29. CORRÊA, 1953a, pp. 130-134, pl. 1, figs. 1-2; 1955, pp. 68-72, pl. 1, figs. 1-3; pl. 2, figs. 4-6. GRIFFIN, 1898, pp. 207-209, figs. 17-18, as *Emplectonema viride*. ISLER, 1901, p. 274. IWATA, 1954, p. 15. JOUBIN, 1890, pp. 585-586, pl. 31, figs. 15-16, 21, as *Nemertes gracilis*. RICKETTS and CALVIN, 1956, pp. 43, 170, 206. STEPHENSON, 1913, pp. 12-13, fig. 6. STIMPSON, 1857, p. 163, as *Emplectonema viride*. YAMAOKA, 1940, pp. 237-238, pl. 4, figs. 1-2; text fig. 14.

MATERIAL. Several worms from March to August, 1958. Localities 1, 2. Very common.

DISTRIBUTION. Northern coasts of Europe to Madeira; Mediterranean; Aleutian Islands and coast of Alaska to Ensenada, Mexico; Chile; Kamchatka to Japan. Intertidal zone to 100 m.

The largest worm measured in life up to 20 cm. in length and 1 mm. in width. The color of the back is uniform dark green. The ventral side is pale yellow or whitish. The color and aspect of the Mediterranean and California worms are not completely alike. The former are stronger and their color is paler than in the California worms (Bürger, 1895, pl. 2, fig. 1; Coe, 1905, pl. 1, fig. 14). The color is still present after preservation in hot "Susa." The head flattened dorsoventrally, wider and lighter than the trunk, contains numerous eyes distributed in two rows on each side: one anterolateral with 12-14 eyes and the other posterolateral with the same number.

Young worms have fewer eyes distributed irregularly. Cephalic furrows are not distinct. The worms have a tendency to coil into a spiral in life and during preservation.

The epidermis is high and rich in mucous glands. The worms make a mucous tube with the fine particles of mud existing between the mussel beds, their most common habitat. The basement membrane is thick and at certain levels thicker than the external circular muscle layer. The longitudinal muscles are high. Both layers reach the tip of the head. Anteriorly to the brain there is a dense muscular net where abundant dorsoventral muscular fibers occur. The cephalic glands are voluminous, distributed dorsally, ventrally, and laterally, reaching as far back as the posterior level of the stomach.

The esophagus opens into the rhynehodaeum. The stomach is large, long, and villous, and its ciliated epithelium is rich in cyanophilous glands. There are two long anterolateral intestinal pouches which join at the beginning of the gut on its sides.

The rhynehodaeum is surrounded by the cephalic glands. The proboscis septum belongs to the closed type. The rhynehocoel has about $1/3$ of the body length. The rhynehocoel wall is composed of a flat epithelium, a layer of longitudinal muscles and a layer of circular muscles. There is a central, curved stylet surrounded by abundant diaphragmatic glands. The wall of the anterior proboscis chamber is composed of a high external epithelium, a layer of circular muscles, a thick layer of longitudinal muscles, and the flat internal epithelium.

In front of the brain there are two blood vessels united by a large commissure. Posterior to the brain there are three blood vessels, one dorsal, situated between the rhynehocoel, and the intestine, and two lateral ones. The dorsal vessel originates from the right lateral vessel.

The nephridia are well developed at the posterior level of the brain and the first part of the stomach.

There are two pairs of cerebral ganglia united by the commissures. The lateral nerve cords have only one core of fibers. The cerebral sense organs are situated ventrolaterally and far anteriorly to the brain.

Besides *E. gracile*, another species of *Emplectonema*, *E. bürgeri* Coe, 1901, is expected to occur on the mussel beds and other growths in the intertidal zone of the localities 1 and 2 where I have collected *E. gracile*. *Emplectonema bürgeri* can be separated from *E. gracile* by the following characters: it is up to 1 m. long; dark velvety brown above and creamy-white below; the base of the stylet is short, only a little longer than the central stylet; the latter is weak and straight. Occurrences: Alaska to Monterey Bay, California; Japan. Intertidal zone to 500 m.

Genus *Paranemertes* Coe, 1901.

REFERENCE: FRIEDRICH, 1955, p. 173.

Up to 50 cm. long, more or less stout; two to numerous eyes; subepithelial glands present, also behind the brain, sometimes reaching region of median gut; longitudinal musculature double layered in anterior part of body, internal and external layer separated from each other by a layer of parenchyma, farther behind the parenchyma disappears and the longitudinal muscular layer is uniform; cephalic glands large but not reaching beyond brain; esophagus opens into rhynchodaeum; caecum of median gut short but with paired pouches; rhynchocoel 1/2 or 1/3 of body length; lateral nerve cords with only one core of fibers; cerebral sense organs small, anterolaterally to brain.

Paranemertes peregrina Coe, 1901.

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 33-36, pl. 2, fig. 6; pl. 3, fig. 5; pl. 7, fig. 7; text fig. 7; 1905, pp. 220-224, pl. 1, figs. 7-9; pl. 16, figs. 95-96; pl. 17, fig. 103; pl. 24, fig. 192; pl. 25, figs. 189-199; text figs. 37-38; 1940, p. 286; 1944, p. 29. IWATA, 1954, p. 15. RICKETTS and CALVIN, 1956, pp. 146-147, 206. YAMAOKA, 1940, pp. 240-243, pl. 17 (in text 4), figs. 3-6; text figs. 17-19.

MATERIAL. Several worms from March to August, 1958. Localities 1, 5. This is one of the commonest and most widely distributed species of nemerteans on the Pacific coast. Very restless, frequently it was found on cloudy days crawling about on the beaches between tides. It occurs from low-tide level well up toward high-water in every habitat, under stones, among seaweeds, barnacles, mussel beds, and on seagrass in mudflats.

DISTRIBUTION. Commander Islands; Aleutian Islands; Alaska to Gulf of California, Mexico; Kamchatka to Japan. Intertidal zone and farther below.

The worms measured in life up to 20 cm. in length and 4 mm. in maximum width. The head is very variable in shape, commonly fan-shaped, flattened dorsoventrally, and a little wider than the adjoining portion of the trunk. The color is also very variable, but the commonest is uniform purplish or dark violet on the back and whitish-yellow on the ventral surface as well as on the margins. The width of the ventral yellow surface is in some worms only a narrow longitudinal stripe, the margins being also purple colored. The color is well preserved after fixation in hot "Susa." The purple head is bordered in front and laterally by the lighter color of the ventral surface. The same color occurs at the posterior border of the head as a small angular spot on each side. Numerous small eyes are arranged in groups on the head. Two groups are situated on the anterolateral margins and the other two are disposed in clusters just in front of the brain.

There is one transverse cephalic furrow, V-shaped, with its apex directed backward.

The glandular epidermis shows the purple pigment of the body in its deepest zone. Before the brain there is a dense muscular net besides the normal muscular layers underneath the epidermis. The cephalic glands are very abundant, scattered among the muscular net fibers and reaching the nephridial region backward. In the anterior part of the body the longitudinal muscles form an internal and an external layer separated by parenchyma. Farther behind the parenchyma disappears.

The esophagus opens into the rhynchodaeum. There are two anterolateral intestinal pouches which reach the posterior border of the brain. They unite under the stomach forming a short median caecum.

The rhynchodaeum opening is a subterminal slit situated ventrally to the frontal sense organ. The rhynchodaeum has a large lumen lined by a high epithelium. The strong proboscis septum, connected with the anterior muscular net, belongs to the closed type. The rhynchoeol reaches about $3/4$ the length of the body. Its wall is composed of a flat epithelium, a layer of longitudinal muscles, and a layer of circular muscles. The wall of the anterior proboscis chamber is composed of a high external epithelium, a layer of circular muscles, a layer of longitudinal muscles, and a flat internal epithelium. The 14 longitudinal proboscidial nerves are located on the outer border of the longitudinal muscular layer. The central stylet is small, slender, and sharply pointed as are the accessory ones. All stylets have a braided appearance. The base is very small and pear-shaped. The number of accessory stylet pouches is 2, and each contains from 4 to 6 stylets.

There are a pair of long and large cephalic blood lacunae in the head joined anteriorly by an anastomosis. The three longitudinal postcerebral vessels are well developed, being two lateral and one dorsal, situated between the rhynchoeol and the gut. The nephridia occupy the region behind the brain and are situated above, below, or lateral to the lateral nerve cords. They are provided with numerous branches.

The brain is very simple. It is composed of two pairs of ganglia. The lateral nerve cords have only one core of fibers. The cerebral sense organs are small, simple, and lie well in front of the brain. They open into a slight furrow on the sides of the head, a little in front of them. A frontal sense organ is present.

KEY FOR THE SPECIES OF *Paramertes*

1. Two ocelli.....
P. biocellata Coe, 1944. No record is available of coloration in life. Occurrence:
 Biloxi, Mississippi. Burrowing in intertidal sand flats and in shallow water.

- More than 2 ocelli.....2
2. With transverse rings.....3
- Without transverse rings.....4
3. Transverse rings as very minute dark brown spots; 12 proboscicial nerves; number of ocelli not known. One can infer from the description of the species (Iwata, 1952, pp. 142-143) that it has more than 2 eyes as it resembles *P. peregrina* with many ocelli.....
P. incola Iwata, 1952. Bright chestnut brown anteriorly, yellow ventrally and marginally. Occurrence: Tomioka, Japan. Under stones near low water-mark.
- Transverse rings whitish; ten proboscicial nerves.....
P. plana Iwata, 1957. Pale brown with numerous whitish dots besides the rings. Occurrence: Sagami Bay, Japan. From 250 to 300 m. Collected by His Majesty the Emperor of Japan.
4. Stylets with braided appearance; 14 proboscicial nerves; 2 pouches of accessory stylets.....*P. peregrini* Coe, 1901.
- Stylets not braided in appearance; less than 14 proboscicial nerves; more than 2 pouches of accessory stylets.....5
5. Opaque white dorsally and ventrally; 9 to 10 proboscicial nerves; 4 pouches of accessory stylets.....
P. pallida Coe, 1901. Occurrence: Alaska. Intertidal zone.
- Not opaque white dorsally and ventrally; variable number of proboscicial nerves and pouches of accessory stylets.....6
6. Pale red dorsally and ventrally; 11 or 12 or 13 proboscicial nerves; 6 to 12 pouches of accessory stylets.....
P. carnea Coe, 1901. Occurrences: Alaska to Puget Sound. Intertidal zone.
- Rosy or pinkish anteriorly, often tinged with yellow or orange, intestinal region gray or salmon; 10 to 13 proboscicial nerves; 2, 4, or 6 pouches of accessory stylets*P. californica* Coe, 1904. Occurrences: Monterey Bay, California to Ensenada, Mexico. In sandy and muddy flats.

BIOLOGICAL OBSERVATIONS AND EXPERIMENTS. The worms were maintained in sea-water at a temperature between 12 to 15° C. They endure better if some fragments of algae are added. These serve as shady shelter and substratum. In general the worms lasted for about 15 to 20 days under these conditions without food.

Their calm and uniform gliding is accompanied by movements of the tip of the snout to both sides or lifting it. Sometimes they contract rapidly, distend, and indulge in corkscrew and antiperistaltic movements. After about 30 minutes, all worms were sheltered under the pieces of algae.

Acephalous fragments (Friedrich, 1933; Eggers, 1924, 1936; Corrêa, 1953, 1953a) decapitated 5 cm. behind the anterior extremity, do not show any locomotion beyond muscular contractions which could produce a change of place. Only very strong stimuli could bring the peripheral

nervous elements to give impulses to the cilia. Cephalic fragments, which contain the brain, behave like complete animals in regard to locomotion. Immediately after the cut, as the cilia continue to beat, they start a calm and uniform locomotion in a rectilinear path. After 24 hours they still are able to present the same sort of locomotion if the water is changed. The accumulation of mucus on the bottom of the dishes impedes the spontaneous gliding.

Paranemertes peregrina belongs to the locomotory type *a* (Corrêa, 1953, p. 548, 554). Spontaneous gliding depends on the brain. The threshold of stimulation of the nervous elements in the postcephalic part is much higher than that of the brain.

The worms are negatively phototactic. When in the nearest corner to the light source of square dishes they glide to the farthest corner. If they have the anterior end directed against the light source they turn round before they glide. The path is very seldom diagonal, as the worms are positively thigmotactic to the borders of the dish. Both paths, the diagonal and the bordering, took the same time to be performed. The same reaction was shown by complete worms and cephalic fragments.

Paranemertes peregrina represents excellent material for classes experiments on food intake in nemerteans, as was already described and illustrated by MacGinitie (1949, p. 162, f. 43). Besides being one of the commonest intertidal species of nemerteans on the California coast, they are voracious feeders (Coe, 1901, 1904, p. 36) and are easily fed in the laboratory with fragments of polychaetes.

Genus **Zygonemertes** Montgomery, 1897.

REFERENCE: FRIEDRICH, 1955, p. 154.

Many eyes, extended backward beyond brain, over and beside the lateral nerve cords, and, specially behind the brain more or less serially disposed; anterior part of body with numerous subepithelial glands (?); esophagus opens into rhynchodaeum; median gut without unpaired caecum directed forward, substituted by two long paired pouches (evidently *Z. capensis* Wheeler, 1934 and *Z. glandulosa* Yamaoka, 1940, with caecum); rhynchocoel reaching the posterior end, its wall double-layered; proboscis thick and short, anterior part of it with only one layer of circular muscles; base of central stylet long, cylindrical, posteriorly truncate, in front of the posterior end generally an annular furrow; lateral nerve cords with one fiber core; anal commissure dorsal to gut; cerebral sense organs large, immediately in front of or near the brain (?), clearly separated from it.

Zygonemertes virescens (Verrill, 1879).

PRINCIPAL REFERENCES: COE, 1905, pp. 214-216, pl. 22, figs. 141-144; 1940, pp. 295-

296, pl. 30, fig. 39; 1943, pp. 270-273; text figs. 63-64; 1944, p. 30; 1951, p. 329; 1951a, pp. 170-171, text figs. 16a-e. CORRÊA, 1961, pp. 25-28. MONTGOMERY, 1897, pp. 2-4, pl. 1, figs. 14-15, 23-24, 28. VERRILL, 1892, p. 400, pl. 33, figs. 4-4e as *Amphiporus virescens*; l.c., pp. 400-401, pl. 35, fig. 4; text fig. 4, as *A. agilis*.

MATERIAL. Three worms in September, 1958. Locality 10. Not common.

DISTRIBUTION. Bay of Fundy, New England, and southward to Miami and Key Largo, Florida, and along the Gulf coast at least as far as Pensacola, Florida; Puget Sound to Gulf of California. Intertidal zone to 120 m.

The living mature worms are up to 3 cm. long and 1 mm. wide. The color is variable from white to yellow and green. There are numerous precerebral eyes disposed in irregular rows and postcerebral ones disposed in only one row on each side.

In living worms, flattened between slide and cover-slide, numerous generally sickle-shaped bodies appear, first described in *Emplectonema echino-derma* (Marion, 1830) (Bürger, 1895, p. 124, 216). At a first glance they seem to be calcareous corpuscles. Probably they are extra-cellular secretions, colorless or pigmented, originated from epidermal cells (Coe, 1943, p. 217). The sickle-shaped bodies can also be seen in clarified worms and in sections, as they do not dissolve in the liquids commonly used for preservation.

The large rhynchodaeal pore leads to a very narrow rhynchodaeum. The proboscis septum belongs to the closed type. The rhynchocoel reaches the posterior tip of the body. The proboscis is much shorter. The rhynchocoel wall is composed of an epithelium, a thick layer of longitudinal muscles, and a thin layer of circular ones. The proboscis wall is composed of a high external epithelium, circular muscles, a double layer of longitudinal muscles, circular muscles, and internal epithelium. There are ten proboscidial nerves. The central stylet is shorter than its base which is truncate and posteriorly lobate.

OTHER SPECIES OF THE GENUS. The genus *Zygonemertes* is quite uniform in its features. Besides size and color the best character to separate its eleven known species (Corrêa 1961, p. 26) is the number of proboscidial nerves. Two more species occur on the West coast of North America. They can be separated from *virescens* as follows:

1. *Zygonemertes thalassina* Coe, 1904. Closely related to *Z. virescens*; 12 proboscidial nerves. Occurrence: Alaska. Intertidal zone.
2. *Zygonemertes albida* Coe, 1904. Number of proboscidial nerves unknown; whitish, small, only up to 25 mm. long. Occurrences: British Columbia to Ensenada, Mexico. Intertidal zone.

Genus **Amphiporus** Ehrenberg, 1831.

REFERENCE: FRIEDRICH, 1955, p. 154.

Generally large, stout forms; seldom none, 2 or 4 eyes, generally many to very many, distributed in groups; cephalic and subepithelial glands present or lacking; cutaneous-muscular tube with or without diagonal layers; dorsoventral muscles generally present; esophagus opens into rhynecho-daeum; caecum with pouches of different length; without diverticula of esophagus, stomach or pylorus; rhynecho-coel as long as body; nephridial apparatus probably always limited to a short stretch behind the cerebral ganglia; cerebral sense organs anterior to brain, maximally reaching under its anterior border, sometimes small, in the tip of the head, sometimes larger and nearer to the brain (the *A. pulcher*-group differs essentially in this point).

Amphiporus cruentatus Verrill, 1879.

PRINCIPAL REFERENCES: COE, 1904, pp. 154-155, pl. 20, figs. 1-6; 1905, pp. 246-247, pl. 1, fig. 13; text figs. 12, 20, 51-52; pp. 279-280, pl. 22, fig. 161, as *A. leptacanthus*; 1940, p. 299; 1943, pp. 279-281, pl. 3, fig. 1, text figs. 66-67; 1944, p. 30. VERRILL, 1892, pp. 399-400, pl. 33, figs. 7-8a; pl. 35, fig. 3, pl. 39, fig. 9.

MATERIAL. Two worms in April, 1958. Locality 1. Uncommon.

DISTRIBUTION. New England to Florida; Puget Sound to San Diego, California. Intertidal zone to 80 m.

The living, mature worms are up to 25 mm. in length. The head is slender, not wider than the rest of the body, with indistinct cephalic furrows. The color is whitish or pale yellow. There are only a few eyes, about 15, distributed irregularly in two rows, one on each lateral margin of the head. The size of the eyes is variable, the most anterior being the largest ones.

The rhynecho-coel is almost as long as the body. The proboscis is also very long and thick. The slender and pointed central stylet is as long as the base. The base is irregularly cylindrical in shape. There are two pouches of accessory stylets each having two to four stylets.

The most striking feature of this small species of *Amphiporus* is the deep red color of the blood, easily seen by transparency through the large vessels in living animals. There are two precerebral vessels united anteriorly by a commissure and three postcerebral ones, two lateral and a dorsal one originated from the right lateral vessel at the level of the brain.

Amphiporus imparispinosus Griffin, 1898.

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 51-53, pl. 7, fig. 6; text fig. 13, as *A. leuciodus*; 1904, p. 115; 1905, pp. 247-249, pl. 16, figs. 99-100; pl. 25, figs. 195-

197; text fig. 53; 1940, p. 300; 1944, p. 30. GRIFFIN, 1898, p. 210, text figs. 19-20. PUNNETT, 1901, p. 95, as *A. leuciodus*.

MATERIAL. Several worms from March to August, 1958. Locality 1. It is one of the commonest nemerteans in the Dillon Beach area.

DISTRIBUTION. Coast of Siberia; Bering Sea; Alaska to San Diego, California and Ensenada, Mexico. Intertidal zone to 50 m.

The slender, elongated worms measured in life up to 20 cm. in length. The head is narrower than the following part of the body which is flattened posteriorly. The color is uniformly opaque white, sometimes with a pinkish or yellowish tinge. There are two groups of eyes on each side of the head. The anteromarginal groups form elongated rows of 10-12 eyes each, and the posterior groups, nearer the median line, have about the same number of eyes.

The glandular epidermis is moderately high. The basement membrane is thick. Both layers of muscles, the external circular and the thicker internal longitudinal one, attain the tip of the head. Before the brain there is a dense net of muscular fibers. The cephalic glands are not very abundant. They reach backward only the posterior level of the brain.

The large esophagus opens into the rhynchodaeum at the level of the cerebral sense organs. There are two large, branched, anterolateral intestinal pouches which reach forward as far as the brain region. They unite beneath the stomach and form a median caecum provided with lateral diverticula. Also the main gut is provided with diverticula.

The rhynchodaeum opens anteriorly by a large opening. It is lined by a high epithelium and contains a thick muscular coat in its most internal part. The strong proboscis septum belongs to the closed type. The rhynchocoel is long, reaching almost the posterior end of the body. Its wall is composed of an epithelium, a layer of longitudinal muscles and a layer of circular muscles. The proboscis wall is composed of a high external epithelium, a layer of circular muscles, a thick layer of longitudinal muscles and a flat internal epithelium. There are 16 longitudinal proboscis nerves, situated in the longitudinal muscular layer. The central stylet is almost as long as the very wide base. The number of pouches of accessory stylets was three in all specimens examined. The number of accessory stylets was 2-3 in each pouch.

There are two precerebral vessels united anteriorly by a commissure and lined by a high epithelium. Posterior to the brain there are three vessels, two lateral and a dorsal one. The nephridia are well developed.

The brain is composed of two pairs of ganglia united by a broad and short ventral commissure and a long and narrow dorsal commissure. The lateral nerve cords have only a core of fibers. The cerebral sense organs

are composed of a series of chambers which open to the exterior by one lateroventral cerebral canal and aperture. They lie far in front of the brain. A frontal sense organ is present.

***Amphiporus formidabilis* Griffin, 1898.**

PRINCIPAL REFERENCES: COE, 1901, 1904, pp. 54-56, pl. 3, fig. 1; pl. 7, fig. 5; pl. 11, fig. 3; text fig. 14, as *A. exilis*; 1904, p. 115; 1905, pp. 250-252, pl. 17, fig. 101-102; text figs. 13, 15, 23, 54, 1940, p. 300, 1944, p. 30. GRIFFIN, 1898, p. 211, text figs. 21-23. IWATA, 1952, pp. 144-146, text figs. 15-16.

MATERIAL. Several worms from March to August, 1958. Localities 1, 8. Very common.

DISTRIBUTION. Bering Island, Aleutian Islands, coast of Alaska and southward to Monterey Bay, California; Japan. Intertidal zone and below.

The slender worms measured in life up to 30 cm. in length and 2-3 mm. in maximum width. The commonest color is uniform opaque-white, sometimes pale yellowish-white. The intestinal canal, brain, and lateral nerve cords can be seen by transparency. The eyes, very small but extremely numerous, up to 250, are distributed in four clusters, two anterior and two posterior in the head.

Before the brain there is a dense muscular net. The cephalic glands are very well developed all around the rhynchodaeum. I could not see their posterior limits because there occur abundant submuscular glands at the brain level which show the same aspect as the cephalic ones.

The large esophagus opens into the rhynchodaeum. There are two branched anterolateral intestinal pouches which reach forward to the brain region. They unite beneath the stomach to form a branched and large median caecum.

The large rhynchodaeum is lined by a high epithelium. At its internal end it is coated by a thick muscular layer. The extremely strong proboscoidal septum belongs to the closed type. The rhynchoeol is long, reaching almost the posterior end of the body. Its wall is composed of an epithelium, a longitudinal muscular layer, and a circular one. The proboscis is of moderate size. The wall of its anterior chamber is composed of an external epithelium, a layer of circular muscles, a thick layer of longitudinal muscles and a flat internal epithelium. There are about 25-30 proboscoidal nerves situated within the longitudinal musculature. The central stylet is slender but its base is very massive. There are usually 6-12 pouches of accessory stylets each bearing 1-2 stylets.

The nephridia are remarkably long and well developed.

The brain is large. The lateral nerve cords have only one core of fibers.

The cerebral sense organs are situated far in front of the brain, ventrolaterally as well as their canal and opening. A frontal sense organ is present.

OTHER SPECIES OF THE GENUS. Eighteen species and one variety of *Amphiporus* are known on the Pacific coast of North America (Coe, 1944, pp. 30-31). Besides the three described here, eight more and the variety could occur in the intertidal zone of the localities where I collected. They can be separated by the following characteristics:

1. ***Amphiporus angulatus*** (Fabricius, 1774). Length 20 cm. or more; dark brown, reddish-brown or purplish-brown on dorsal surface, with paler margins and conspicuous angular whitish spots on each side of head, continuous with whitish ventral surface; a pair of elongated clusters of ocelli situated on the anterolateral borders of the head and a posterior group lies in or near the angular white spot on each lateral margin of head. Occurrences: Circumpolar; Greenland; Davis Strait; Labrador to Cape Cod; Bering Strait; Bering Sea; Aleutian Islands and Kamchatka to Japan; Alaska; British Columbia and southward to Point Conception, California. Intertidal zone to 150 m. or more.
2. ***Amphiporus tigrinus*** Coe, 1901. Length 10 cm.; color of various shades of lemon, yellow, and yellowish-brown; ocelli irregular in shape and variable in size arranged in two irregular and indistinctly separated clusters on each side of head. Occurrences: British Columbia and Puget Sound. Intertidal zone.
3. ***Amphiporus bimaculatus*** Coe, 1901. Up to 15 cm. long; dorsal surface, behind the head, deep red, brownish-red or brownish-orange, sometimes yellowish; head whitish with two angular or oval black or very dark brown spots placed symmetrically on dorsal surface; ventral surface pale reddish, or pale orange; ocelli arranged in an irregular, elongated cluster on each anterolateral margin. Occurrences: Sea of Okhotsky; Alaska to Ensenada, Mexico. Intertidal zone to 250 m.
4. ***Amphiporus fulvus*** Coe, 1905. Length 15 to 25 mm. or more; pale brownish anteriorly, deep brown in intestinal region, much paler beneath; head pale brown; color of body consists of innumerable minute dark brown spots scattered thickly over the ground color. Occurrence: southern California. Intertidal zone to 85 m.
5. ***Amphiporus californicus*** Coe, 1905. Length 10 to 25 mm. or more; deep red orange with an opaque white tinge, dark, dull yellowish red, or bright red; ventral surface duller and with more whitish. Occurrence: southern California. Intertidal zone to 80 m. or more.

6. **Amphiporus punctatulus** Coe, 1905. Between 35 and 50 mm. in length; in preserved specimens the whole surface of the body is dark mottled brown, the color consisting of innumerable dark dots which run together, forming irregular blotches; the mottling is less complete on the ventral surface. Occurrence: Catalina Island, California. Intertidal zone.
7. **Amphiporus rubellus** Coe, 1905. Length 25 mm. or more; pale orange, or pale red; much paler and usually grayish beneath. Occurrence: southern California. Intertidal zone to 200 m.
8. **Amphiporus flavescens** Coe, 1905. Up to 20 mm.; color very variable, usually whitish, or pale yellow; there are commonly 12 to 25 ocelli arranged in two groups on each side of head. Occurrences: Monterey Bay, California to Ensenada, Mexico. Intertidal zone.
9. **Amphiporus imparispinosus** Griffin, 1898 var. *similis* (Coe, 1905). Differs from the species in having two instead of three pouches of accessory stylets. Occurrences: Puget Sound to Ensenada, Mexico. Intertidal zone and below.

Genus **Tetrastemma** Ehrenberg, 1831.

REFERENCE: FRIEDRICH, 1955, p. 170.

Generally small, slender worms; tip of head with circular and longitudinal muscles as well as retractors; cephalic glands present, very variable in size, sometimes reaching far beyond brain; esophagus opens into rhynchodaeum; caecum of midgut present, with lateral pouches and two more pouches directed forward; pouches of midgut shallow, generally not branched; rhynchocoel as long as body (except *T. hansii* Bürger, 1893), without diverticula; precerebral septum (as far as known) closed; nephridia short, generally with one or two pores; lateral nerve cords with one fiber core; cerebral sense organs generally large situated in front of brain, exceptionally in cerebral region; generally dioecious (except *T. marioni* Joubin, 1890 and *T. caecum* Coe, 1901).

Tetrastemma nigrifrons Coe, 1904.

PRINCIPAL REFERENCES: COE, 1904, pp. 159-164, pl. 15, fig. 7; pl. 16, figs. 6-9; pl. 17, fig. 1; pl. 20, fig. 16; pl. 21, figs. 15-23; 1905, pp. 289-293, pl. 2, fig. 26; pl. 18, figs. 111-115, text figs. 57-59; 1940, pp. 305-306; pl. 31, fig. 42; 1944, p. 31. IWATA, 1954, pp. 30-32, fig. 8 B 1-8; 1957, p. 27, pl. 1, fig. 14. YAMAOKA, 1940, pp. 249-251, pl. 3, fig. 14; figs. 9-12; textfigs. 26-29, as *Prostoma nigrifrons*.

MATERIAL. Two worms in May, 1958. Locality 1. Uncommon.

DISTRIBUTION. Puget Sound to coasts of Mexico and Costa Rica; Japan. Intertidal zone.

Both worms were 30 mm. long. Variations in color and markings are so striking that several species appear to be represented by individuals which actually present all degrees of intergradation (Coe, 1905, p. 290). My worms had a whitish head with a large, quadrangular dark-brown dorsal marking and a purplish-brown trunk. Their coloration is close to that given by Coe (1904, 1905, 1940) for the variety "purpuratum." Four eyes are situated one on each corner of the head marking.

OTHER SPECIES OF THE GENUS. Besides *T. nigrifrons*, five more species of *Tetrastemma* could occur in the intertidal zone of the localities where I have collected. They can be separated by the following external characteristics:

1. ***Tetrastemma candidum*** (Müller, 1774). Recently redescribed by Corrêa (1961, p. 40) is up to 20 mm. long and uniformly whitish or pinkish-white in color. Occurrences: Circumpolar; Greenland and Norway to Madeira; South Africa; Labrador to New England and southward to Miami and Key Largo, Florida; Alaska to Ensenada, Mexico. Intertidal zone.
2. ***Tetrastemma bilineatum*** Coe, 1904. Only 5 to 10 mm. long; general color creamy or grayish with two sharply defined brown stripes extending nearly along whole length of dorsal surface. Occurrence: San Diego, California. Intertidal zone.
3. ***Tetrastemma quadrilineatum*** Coe, 1904. Long 8 to 12 mm.; general color of body whitish with four longitudinal brown stripes, two of which are situated near lateral margins of body and the other two placed on dorsal surface. Occurrences: Monterey Bay, California to Ensenada, Mexico. Intertidal zone.
4. ***Tetrastemma reticulatum*** Coe, 1904. About 8 to 15 mm. long; ground color white with rectangular and longitudinal brown markings; head provided with a brown marking. Occurrence: southern California. Intertidal zone.
5. ***Tetrastemma signifer*** Coe, 1904. About 15 to 25 mm. long; general color of body deep reddish-brown or purplish except for the head which is white with a dark brown marking formed by a transverse, basal portion, from which two semicircular branches pass anteriorly. Occurrences: Monterey Bay, California to San Diego, California. Intertidal zone to 10 m.

Genus **Prostoma** Dugès, 1828.

REFERENCE: FRIEDRICH, 1955, p. 162.

In general small, up to 3.5 cm. long; none to six eyes; muscular-cutaneous tube without diagonal layer; tip of head with longitudinal muscles; cephalic glands short, only precerebral; midgut without or with very short unpaired blind pouch; only with two pouches directed forward; special pylorus tube not developed; true esophagus absent; rhynehocoel generally not reaching the posterior end, its wall musculature not crossed; blood vessels without brain commissures, the dorsal vessel arises from one of the lateral vessels; nephridia well developed, with many pores; cerebral sense organs before the brain, relatively simple; hermaphrodite.

? **Prostoma rubrum** (Leidy, 1850).

PRINCIPAL REFERENCES: COE, 1940, p. 308; 1943, pp. 299-301, text fig. 75; 1959, pp. 366-367, text fig. 14. CORDERO, 1943, pp. 125-134, figs. 1-2. CORRÊA, 1951, pp. 257-264, pl. 1, figs. 1-5; pl. 2, figs. 6-11. MONTGOMERY, 1896, pp. 436-438. RIOJA, 1941, pp. 663-668, text figs. 1-4. WIJNHOF, 1938, pp. 219-230.

MATERIAL. Three worms in August, 1958. Locality 3. The species occurs in large numbers at that season (Coe, 1943, p. 299).

DISTRIBUTION. New England to Georgia and Florida and westward to Ohio, Nebraska, Washington, and California; Xoehimileo, Mexico and perhaps Caracas, Venezuela.

The living worms were up to 18 mm. long and 1.5 mm. wide. The anterior end is rounded and the posterior is pointed. The color of the three specimens was pale yellow or whitish. There are three pairs of small eyes disposed in two rows in front of the brain. An indistinct transverse cephalic furrow is present at the posterior level of the eyes.

The rhynehocoel is long as is also the proboscis. The central stylet is short. The base is pear-shaped and as long as the stylet. Two pouches are present, each containing 2-4 accessory stylets.

The unfavorable conditions of collecting and preserving made it impossible to obtain more information and a larger number of specimens.

In her synopsis of the genus *Prostoma*, Stiasny-Wijnhoff (1938) records 16 different names applied to freshwater nemerteans and gives their bibliography. Six species are recognized as valid in her revision, viz., *P. lumbricoideum* Dugès, 1828; *P. gracense* (Böhmig, 1892); *P. eilhardi* (Montgomery, 1895); *P. grande* (Ikeda, 1913); *P. padanum* Pierantoni, 1926; and *P. puteale* Beauchamp, 1932. Strangely enough, *P. rubrum* (Leidy, 1850) does not figure in Wijnhoff's list, although Coe (1940, 1943, 1959) revalidated this name for the specimens described from North America

(*P. aquarum-dulcium* Silliman, 1885, from New York State and *P. asensoriatum* Montgomery, 1896, from Pennsylvania) and Rioja, 1941, for specimens found in Xochimileo, in the vicinity of Mexico City, the most meridional known occurrence of the species. The South American specimens from Venezuela (Cordero, 1943) were not determined; they could belong to *P. rubrum* as the frontal sense organ was stated (p. 129) as absent. Friedrich (1955, p. 163) records *P. rubrum* in his list of species of *Prostoma*.

Wijnhoff (p. 6) considers the North American species and *P. graccese* as identical, but hesitated to introduce the corresponding change of the name because she had not seen North American material. As the name *P. asensoriatum* indicates, the American species has no supra-oral or frontal sense organ. In Montgomery's opinion (1896, p. 436) the cephalic glands of *P. asensoriatum* open individually, scattered on the frontal side. *Prostoma graccese*, however, has a frontal organ toward which the ducts of the cephalic glands converge (Böhmig, 1898, pp. 481, 536). Even Reisinger (1926, pp. 2-3), who unites all central European species under the name of *P. graccese*, maintains the North American species separated.

The living worms from California examined with regard to the presence of a frontal sense organ have shown it, and I confirmed it in preserved and cleared state as well as in sections. However, the sections were not good enough to reveal other very delicate characteristics of this species, *e.g.*, the ciliated epithelium in the esophagus and true layer of thick longitudinal muscles of the rynchodaeum (Corrêa, 1951, pp. 259, 262). In the sections of the California worms I did not see the calcareous corpuscles in the parenchyma characteristic of *P. graccese*. Only further study of the California species of *Prostoma* could elucidate its exact systematic status.

Malacobdella blainville, 1827.

REFERENCE: FRIEDRICH, 1936, p. 44.

Posterior end of body with a sucker; buccal cavity villous, serving for food intake; intestine sinuous; midgut without lateral pouches; rynchodaeum absent; proboscis without stylet.

Malacobdella grossa (Müller, 1776).

PRINCIPAL REFERENCES: BÜRGER, 1895, p. 597, pl. 18, figs. 1-5; pl. 23, fig. 39; pl. 27, figs. 21-23; pl. 28, figs. 25, 28, 39. COE, 1940, p. 310; 1943, pp. 309-310, text fig. 79; 1944, p. 32. GERING, 1911, pp. 673-720, pl. 32, figs. 1-13; text fig. 1. GUBERLET, 1925, pp. 1-13, pl. 1. HAMMARSTEN, 1918, pp. 1-95, figs. 1-26, text figs. 1-18. RICKETTS and CALVIN, 1956, pp. 195-196. RIEPEN, 1933, pp. 323-496; text figs. 1-63 (the most complete work done on the species). VERRILL, 1892, pp. 444-445, pl. 39, fig. 23, text fig. 9, as *M. obesa* and *M. mercenaria*.

MATERIAL. One worm in July, 1958. Locality 4. A second specimen was received from Dr. Liliansa Forneris, Oceanographic Institute, São Paulo, (Brazil), collected during her stay at the University of Kiel (Germany), 1959. The latter worm was found in the mantle cavity of the lamellibranch *Arctica (Cyprina) islandica* (Linnaeus). Occurrence: Stoller Grund, Bay of Kiel, Germany. *Riepen* (1933) studied material from the same locality.

DISTRIBUTION. Northern coasts of Europe, Mediterranean; Nova Scotia to Chesapeake Bay, Atlantic coast of North America and Puget Sound to California, Pacific coast.

The length of both present specimens, in preserved state, was about 15 mm. The maximum width, situated at the posterior half of body, was 5 mm. The body is short, broad, and thick. The anterior end is rounded and contains a large and excavated mouth, which serves as aperture for the atrium and proboscis. The posterior end is provided with a sucker. The worms cleared in clove oil showed atrium, esophagus, stomach, midgut, rectum, anus, brain, nervous commissures, lateral nerve cords, proboscis, rhynchocoel, and gonads.

The broad, villous atrium extends from near the tip of the head to the brain commissures where the proboscis opens into its dorsal wall. Posterior to the proboscis opening the digestive canal continues as esophagus without any change in size of lumen or in character of the lining epithelium of short ciliated cells. The esophagus is followed by the stomach. Its lumen is narrower, the ciliated epithelium is higher and the subepithelial glands in the parenchyma become more numerous. There is only a gradual transition in the lumen and epithelium of the esophagus and stomach and of the stomach and midgut. The midgut bends alternately to the left and right, forming at least six loops on the right and seven on the left side. The midgut terminates in the rectum which opens by the anus on the dorsal side of the sucker.

The rhynchocoel extends nearly along the whole length of the body, while the proboscis is much shorter reaching backward less than half that length. The unarmed proboscis fills most of the rhynchocoel and follows its coiling. The unusually long proboscidial retractor attains the posterior end of the rhynchocoel.

There are two much branched and convoluted lateral vessels united by three commissures, one anterior cephalic, one esophageal, situated on the dorsal side of the esophagus, from where the convoluted dorsal vessel arises, and one anal which unites the three vessels behind. The dorsal vessel lies between rhynchocoel and gut; the lateral vessels run on the sides of the body, close to the lateral nerve cords.

A single pair of nephridia extend from near the brain to the region

of the stomach. The branched tubules lie in the parenchyma close to lateral nerve cords and lateral vessels. They unite posteriorly to form a pair of large efferent ducts which lead to the exterior on the ventrolateral surface of the body.

The long cerebral ganglia are widely separated by the broad atrium and connected by a small dorsal and a large ventral commissure. The ventral commissure passes between rhynchocoel and atrium and the dorsal one between rhynchocoel and body wall. Anterior, lateral, and posterior nerves arise from the ganglia. The lateral nerve cords are united posteriorly by a slender suprarectal commissure. Some other commissures and nerves arise from the cords along their course. Eyes and sense organs are wanting.

Both specimens, sexually mature females, had many ovaries situated on both sides of the body, irregularly scattered from the limit between esophagus and stomach to the rectal region. Each gonad has a dorsal opening.

The Order Bdellomorpha consists of a single genus, *Malacobdella*. Besides the here-described species, three more are known which can be separated by the somewhat modified Coe's key (1945, p. 67).

- | | |
|---|--|
| 1. Commensal in marine lamellibranchs..... | 2 |
| — Commensal in fresh-water gastropods..... | <i>M. auriculæ</i> Blanchard, 1847. Occurrence: Chile. In the pallial cavity of <i>Chilina dombeyana</i> Brug. |
| 2. Proboscis sheath nearly as long as body; posterior commissure of nerve cords on dorsal side of rectum..... | 3 |
| — Proboscis sheath only two thirds as long as body; posterior commissure of nerve cords in sucker..... | <i>M. japonica</i> Takakura, 1897. Occurrence: Coasts of Japan. Commensal in the mantle cavity of <i>Spisula sachalinensis</i> . |
| 3. Nephridiopores on dorso-lateral surfaces; gonads large, situated in a single row on each side of body..... | |
| | <i>M. minuta</i> Coe, 1945. Occurrence: Off Point Loma, Southern California, at a depth of 40 m. Commensal in the mantle cavity of <i>Yoldia cooperi</i> Gabb. |
| — Nephridiopores on ventro-lateral surfaces; gonads relatively small and numerous, irregularly scattered..... | <i>M. grossa</i> (Müller, 1776). |

As the main purpose of this paper is to determine the intertidal species of nemerteans occurring along the California coast, I add a list of 11 more species not collected by me but recorded by Coe (1944, pp 27-32).

1. **Carinomella lactea** Coe, 1905. Recently redescribed by Corrêa, (1961, pp. 8-11, fig. 8). Length 50-100 mm.; general color of body milk-white, more or less translucent; after preservation a brown band appears about 5 mm. back from the tip of the head, which fades backward. Occurrences: Biscayne Bay, Miami, Florida; Monterey Bay, California to San Diego, California. Intertidal zone to 20 m.

2. **Baseodiscus punnetti** (Coe, 1904). Large species, 40–60 cm. long; general color deep brownish-red; anterior tip is much deeper brown, marked off from a narrow terminal and lateral white border; ocelli as an irregular longitudinal row of 40–60 or more on the anterolateral margins of head. Occurrences: Monterey Bay, California to Gulf of California, Mexico. Intertidal zone to 380 m.
3. **Zygeupolia rubens** (Coe, 1895). Rather slender, 5–8 cm., long; head pure white; esophageal region white or pale yellow; intestinal region from rose to pale yellow, light brown or chocolate-brown; white caudal cirrus present; cephalic furrows absent. Occurrences: New England and southward to North Carolina; Monterey Bay, California to Ensenada, Mexico. Intertidal zone to 50 m.
4. **Euborlasia nigrocincta** Coe, 1940. Up to 50–70 cm. long; there are two color varieties: the darker is rich purplish brown dorsally and ventrally; head white with fine red or brown dots except the tip; the paler is rosy with reddish brown or purplish dots dorsally; head white or pink; ocelli absent. Occurrences: San Francisco Bay, California; Monterey Bay, California to Ensenada, Mexico. Intertidal zone to 30 m.
5. **Nemertopsis gracilis** Coe, 1904. Commonly 10–15 cm. long; whitish with two longitudinal bands of deep brown along the whole length of body; four ocelli. Occurrences: Puget Sound to Ensenada, Mexico. Intertidal zone and below.
6. **Nemertopsis gracilis** var. **bullocki**, 1940. Differs from the typical form in having the longitudinal brown bands connected anteriorly and sometimes interrupted at intestinal region. Occurrence: coast of central California. Intertidal zone.
7. **Dichonemertes hartmanae** Coe, 1938. Small, 10–15 mm. long; pale red or yellowish with deep red blood; four ocelli; hermaphrodite. Occurrence: San Diego, California. Intertidal zone.
8. **Carcinonemertes epialti** Coe, 1902. Commensal on crabs of the genera *Portunus*, *Pugettia*, and *Euphyllax*. Occurrences: Monterey Bay, California, to San Diego, California; Peru.
9. **Ototyphonemertes spiralis** Coe, 1940. Minute, 3–5 mm. long; white, gray, straw color or yellow; ocelli absent; statocysts containing statolith with 8, 12, or 16 globules. Occurrence: San Diego, California. On sandy shores of bays.
10. **Prosorhochmus albidus** (Coe, 1895). Usually 10–15 mm. long; milk-white or creamy; four ocelli; two ocelli of same side united by a fine line

of dark pigment. Occurrences: Monterey Bay, California, to Ensenada, Mexico. Intertidal zone.

11. *Oerstedtia dorsalis* (Abildgaard, 1806). Recently redescribed by Corrêa (1961, pp. 23-24). Up to 15 mm. long; color light cream irregularly spotted with brown of various shades and with considerable variations in shape and distribution; four ocelli. Occurrences. Circumpolar; Norway to Mediterranean; Madeira; Nova Scotia to Miami, Florida and Key Largo, Florida; Puget Sound to Gulf of California. Intertidal zone and below.

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